Ontario

Updating Ontario's Air Dispersion Models

A Discussion Paper

Air Dispersion Models and technical information relating to Ontario Regulation 346 (under the *Environmental Protection Act*) as amended

March, 2001

Executive Summary

The Ministry of the Environment's commitment to ensuring cleaner air remains a high priority. The Ministry continues to focus on finding solutions to problems that pose the greatest risk to human health and the environment. We have been active in the development and improved implementation of new air quality standards in Ontario. These initiatives include:

- use of the latest scientific information to develop protective, effects-based air standards;
- a risk management framework with the ultimate goal of implementing the effects-based air standards while allowing for time, technology and economic issues to be considered; and
- an update of the Ontario Regulation 346 air dispersion models to ensure that the latest scientific tools to assess compliance with air standards are being used.

The Ministry of the Environment (MOE) has released on the Environmental Registry (under the Environmental Bill of Rights (EBR)) the following three initiatives:

Air Standards

Following consultation in February, 2000 (and previous consultation in 1998), MOE has posted, on the Environmental Registry, decisions on 18 high priority air standards. In addition, one air standard has been re-posted as a proposal recommending a change from our original proposal based on stakeholder input and reassessing the standard. In summary, one new air standard has been finalized; two air standards are more stringent final effects-based numbers; and four Point of Impingement air standards have been reaffirmed as being protective at their current level. Risk management issues were identified for 11 of these air standards. One standard (plus two from March, 1998) will remain unchanged in the interim until discussions are held on implementation issues. Ten interim, but more stringent, air quality standards have been set pending discussions on the proposed risk management framework. Any new or revised standards will take effect six month from the date of the Environmental Registry posting. MOE plans to incorporate these standards into Ontario Regulation 346.

A Proposed Risk Management Framework for Air Standard Setting in Ontario

MOE has developed a proposal for a risk management framework that is intended to address time, technical and economic issues that arise as a result of new or modified air standards. The framework contemplates the use of options, incentives and enhanced enforcement to promote earlier and effective implementation of air standards while improving operational flexibility and equity amongst the regulated community. The proposal outlined in the discussion paper entitled: "A Proposed Risk Management Framework for the Air Standard Setting Process in Ontario" was released on the Environmental Registry in March, 2001 for a 150 day comment period.

New Air Dispersion Models

Ontario proposes to phase-out the existing Ontario Regulation 346 air dispersion models and replace them with the suite of United States Environmental Protection Agency (US EPA) air dispersion models (in particular AERMOD and ISC-PRIME). The adoption of the US EPA models will promote the use of the most modern scientific tools available to assess compliance with air quality standards. A key advantage to introducing the new air dispersion models is the ability to use effects-based standards with appropriate averaging times to assess compliance. The ability to model concentrations using appropriate averaging times provides a more representative assessment of health and environmental impacts from air emissions. This discussion paper entitled: "Updating Ontario's Air Dispersion Models" was released on the Environmental Registry March, 2001 for a 120 day comment period. Implementation issues such as appropriate phase-in period for the models are included for public consultation.

MOE has been active in the development and improved implementation of new air standards in Ontario. We are committed to ensuring that our tools for predicting air emission impacts and assessing compliance are state-of-the-art science. The proposed new air dispersion models will allow for a more accurate assessment of environmental effects from a facility. The impact of introducing new air dispersion models coupled with new or revised air quality standards may create implementation issues for some stakeholders. Issues related to time, technology and/or economic considerations are dealt with in the companion discussion paper entitled: "A Proposed Risk Management Framework for the Air Standard Setting Process in Ontario"

MOE continues to look for innovative approaches to complement legislation and regulations. These include working with communities, industries and organizations towards finding flexible, practical, cost-effective ways to strengthen environmental protection. These three initiatives support this vision and we invite all stakeholders to comment on our proposals.

Updating Ontario's Air Dispersion Models

A Discussion Paper for Consultation with Stakeholders

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1.0 Introduction

The Ministry of the Environment (MOE) is proposing to phase-out the existing Ontario Regulation 346 (O. Reg. 346) air dispersion models and replace them with the suite of United States Environmental Protection Agency (US EPA) air dispersion models. The adoption of the US EPA models into Ontario will promote the use of the most modern scientific tools available to assess compliance with air quality standards. Air dispersion models are used to predict maximum ground level concentrations or Point of Impingement (POI) concentrations at locations in the vicinity of facilities that emit contaminants into the air. These concentrations are then compared to the MOE "Summary of Point of Impingement Standards, Point of Impingement Guidelines and Ambient Air Quality Criteria (AAQCs), Standards Development Branch, Ministry of the Environment", dated November 1999 (or most recent revision) on air quality standards[1].

The existing air dispersion models are outlined in an appendix to O. Reg. 346. These models have been in place for over 30 years and do not reflect the latest scientific advancements in dispersion modelling. As a result, O. Reg. 346 models may under predict maximal ground level concentrations of contaminants or POI. MOE proposes to replace this appendix to the regulation with an MOE Air Dispersion Modelling Guide that would outline acceptable air dispersion models for widespread use in Ontario. The suite of air dispersion models[2] outlined in the proposed US EPA Appendix W GUIDELINE ON AIR QUALITY MODELS will herein be referred to as the "new models" for Ontario.

Air dispersion models are important tools that can be used to assess the likelihood of compliance with Ontario's air quality standards at a particular location. Models can also be used to predict impacts from accidental releases to the environment (i.e. fires, emergency bypasses, plant malfunctions, etc.) when ambient air monitors are not available to measure actual concentrations or when there is no technology available to measure a particular component in the ambient air. Finally, models can assist in determining where an ambient air monitor should be located.

There are two major regulatory applications of the air dispersion models: 1) in the Certificate of Approval (Air) process; and, 2) for abatement and compliance purposes.

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1 The term "standard" used in this document includes any numerical environmental concentration limit set by MOE.

2 The US EPA Notice on Proposed Changes to the suite of air dispersion models can be found in Part 51, Chapter 1, title 40 of the Code of the Federal Register (CFR), Appendix W to Part 51 -- GUIDELINE ON AIR QUALITY MODELS, www.epa.gov/ttn/scram/ which includes Appendix A - Summary of Preferred/Recommended Models.

A Certificate of Approval (C of A) is required for all air sources[3] or proposed amendments to existing sources. Modelling is used in the C of A process to assess the likelihood of compliance with Ontario's air quality standards. This MOE assessment determines whether or not a C of A for a change in air emissions will be issued to a company. Even though the use of the new models is not widespread in Ontario, there have been situations where proponents have either requested or been required to model their emissions using one of the new air dispersion models. However, in the majority of cases to date, particularly in the approvals process, MOE has used O. Reg. 346 air dispersion models to assess POI concentrations.

Air dispersion models can also be used for abatement or compliance assessment purposes. Models can be used by MOE or proponents to assess the likelihood of impacts from a facility on the surrounding community. There are a number of reasons why MOE may request an emitter to undertake a compliance assessment of a particular facility. These include, but are not limited to: a known or anticipated impact from a facility's air emissions on the surrounding community; evidence or indications of an exceedance in ambient air quality standards that appear to be linked back to a facility; and/or a selected target audit of a facility by MOE staff. An assessment for abatement or compliance purposes could be formally requested by a Provincial Officer or legally required by MOE through a legal instrument such as a Director's Order or a C of A issued under the *Environmental Protection Act.*

Of the current preferred US EPA model suite, the most commonly used air dispersion model is the Industrial Source Complex model 3 (ISC 3) and its screening version called SCREEN3. However, the US EPA is in the process of adopting the next generation of air dispersion models namely AERMOD and ISC-PRIME. MOE prefers to go directly to the adoption of the AERMOD, ISC-PRIME models after the phase-in period. Other more appropriate air dispersion models will also be accepted by MOE if a proponent can demonstrate that an alternate model is more appropriate to assess their facility. A detailed description of the proposed models is provided in Appendix A of this paper (Outline for MOE "Air Dispersion Modelling Guide", Section A.1).

This discussion paper outlines:

- the need for change (Section 2);
- the issues for discussion with stakeholders (Section 3);
- the next steps (Section 4);
- the proposed MOE guide and the technical aspects of the new models (Appendix A);
- frequently asked questions about the introduction of the new models into Ontario (Appendix B); and
- a proposal to introduce effects-based air quality standards with appropriate averaging times into O. Reg. 346 (Appendix C).

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[3] For exemptions from the air approvals process, please refer to the Approvals Exemption Regulations (AERs): O. Regulation 524/98 and 505/99.

2.0 Why do we need to change?

Throughout the day, atmospheric conditions change with the weather and the earth's temperature (see Table I). The atmosphere can be considered unstable (daytime conditions and clear skies); stable (night-time and calm to light winds); or slightly unstable to neutral (overcast skies at day or night, and/or strong winds). These atmospheric conditions as well as meteorological factors such as wind speed and wind direction, can impact the behaviour of a stack plume or air emissions (see Figure A). The behaviour of the stack's plume, and/or the degree of dispersion, determines the concentration of a contaminant at any particular location. Air dispersion models mathematically predict the behaviour of a stack plume; and how it may be impacted by atmospheric and meteorological conditions. The output from the air dispersion model is a contaminant concentration at a certain location which is then assessed against the air quality standard.

Table 1: Broad Guide to Atmospheric Stability Classes

Assumed Stability Classes		General Condition of the Atmosphere
A & B	Unstable	daytime, relatively clear skies, light winds
C & D	Slightly Unstable to Neutral	overcast skies (day or night), and/or stronger winds
E & F	Stable	night-time, calm to light winds

Current O. Reg. 346 models only consider slightly unstable and neutral atmospheric conditions (i.e. mainly C & D stability) and make some very broad assumptions about wind speeds and other meteorological factors. There are many sources which can have maximum impacts in more unstable or more stable atmospheric dispersion conditions. As a result, O. Reg. 346 models can under predict maximal ground level concentrations or POI of contaminants. The largest difference between the existing O. Reg. 346 models and the new models occurs when there are: 1) low exit velocity vents or short stacks on buildings; or 2) very tall stacks. These conditions are quite common in Ontario.

The proposed new air dispersion models are better tools to predict maximum ground level concentrations or POI concentrations of contaminants. They consider all atmospheric stabilities (i.e. stable, neutral and unstable) and can also incorporate actual or representative meteorological data into the model. Atmospheric and/or meteorological conditions can significantly affect plume behaviour and the predicted concentration of a contaminant. The US EPA preferred models include more recent science than was available in the development of O. Reg. 346 models and have more realistic treatments for several of the processes that affect dispersion. This is especially true for the new models, AERMOD and ISC-PRIME, which US EPA has proposed as its preferred models for most regulatory applications. Hence, the new air dispersion models are better assessment tools for predicting maximum ground level or POI concentrations of contaminants.

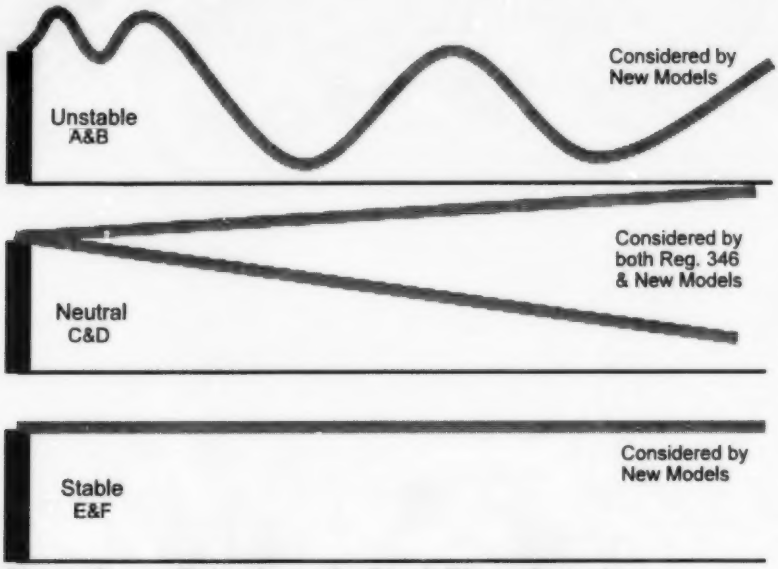

Figure A: Behaviour of a Stack Plume in various Stability Classes

One of the other key features of the new proposed air dispersion models is their ability to determine contaminant concentrations over a range of averaging times – from 1 hour up to 1 year. This feature of the new models allows from a more realistic assessment of health and environmental impacts from a facility by using the most appropriate averaging time for exposure. The effects of a contaminant can then be assessed using modelled exposure concentrations over the most appropriate averaging time for that contaminant. For example, the effects-based averaging time for health-based air standards is 24 hours (or daily) exposure: this is typically referred to as the Ambient Air Quality Criteria or AAQC. With the existing O. Reg. 346 models, assessment of a facility is done using the maximum ½ hour emission rate and comparing that to a conservative "screening level" concentration typically referred to as the maximum ground level concentration. If a facility meets the screening level or maximum ½ hour concentration, then it is likely to meet the effects-based standard with appropriate averaging time concentration for that air quality standard. The proposed new air dispersion models allow for an assessment of the effects-based air quality standards using the most appropriate averaging time for that contaminant. This means that for facilities where emissions only occur for part of the day or vary significantly during the day, emission rates for the actual operating times could be used in assessing compliance with a 24 hour effects-based air quality standard rather than the historical maximum ½ hour POI standard.

This important feature of the new models allow for a more accurate assessment of true environmental and/or health impacts from air emissions rather than being constrained to using POI "screening levels" only for regulatory purposes. For more information on "effects-based averaging times", please see Section 3.5.

3.0 What do we need to discuss?

Prior to adopting the widespread use of these new models in Ontario, MOE is undergoing consultation with stakeholders. MOE needs to hear from stakeholders on the following key issues:

- Phasing-in the new models
- Managing in the interim
- Using simple screening methods (A Tiered Approach)
- Discussing background ambient air concentrations
- Applying statistics to modelling
- Introducing effects-based averaging times
- Ensuring consistent use of models
- Linkages to the Air Standard Setting Process
- Identifying other stakeholders issues

Each of these issues are discussed in the following sections.

3.1 Phasing-in the new models

The formal adoption of the new air dispersion models into Ontario could mean a change in the compliance status of some facilities. A facility may be in compliance one day using the O. Reg. 346 models and, without having made any physical or raw material changes to their processes, show non-compliance with the POI air quality standards[4] tomorrow using the new models (the reason for these differences is outlined in Section 2.0). Dealing with such differences in predicted concentrations is one of the reasons why the phase-in period to introduce the new models is so important. Industrial stakeholders will need time to assess their overall plant emissions using these new models and address compliance issues where necessary. It will also take time for users of the new air dispersion models to acquire and familiarize themselves with the models. Although many in the consulting community and some industries are familiar with the new models, many are not. Hence, an appropriate phase-in period for formally adopting the widespread use of the new air dispersion models into Ontario is a key matter for discussion. MOE proposes to phase-in the use of the new models over a 3 to 5 year period that begins once the MOE "Air Dispersion Modelling" guide has been finalized and O. Reg. 346 has been amended.

Decision Box 3.1: Phase-in Period

3.1 Proposal for discussion:

MOE is looking for input from stakeholders on the appropriate phase-in period for adopting the widespread use of the new air dispersion models into Ontario. By setting an appropriate phase-in period, industry will be able to assess their compliance status using the proposed new models and develop business plans to address any compliance issues. Following consultation on this discussion paper, MOE will draft for consultation an MOE "Air Dispersion Modelling Guide". Once the guide is finalized (approximately 2002), MOE will amend O. Reg. 346 to reflect the changes in air dispersion modelling.

Questions for stakeholders:

3.1.1 A 3 to 5 year phase-in period from the time the regulation is amended is being proposed. Assuming the MOE guide is finalized by 2002, this means that the new models would be implemented in 2005-2007. Is this an appropriate phase-in period for the new models?

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[4] The differences highlighted here are assuming POI standards alone continue to be used as the regulatory limit. If, as proposed, MOE adopts the use of effects-based standards with appropriate averaging times, this allows for a more realistic assessment of impacts (see Section 3.5 for details).

3.2 Managing in the interim

In the Certificate of Approval (Air)(C of A) process, MOE's proposal is to accept model results using either the new models or the O. Reg. 346 models[5] during the phase-in period. Introduction of the new dispersion models into Ontario will not change the status of a company's C of A. Existing C of As will still be valid during the phase-in period and after the introduction of the new models even if approval was obtained using the O. Reg. 346 models. Under Section 9 of the *Environmental Protection Act*, the Director has the authority to amend or revoke a C of A at any time. Hence, for business planning purposes, amendments to C of As should not be linked to the introduction of the new air dispersion models.

If the models are being used to assess an identified abatement issue in the local community, the existing O. Reg. 346 allows MOE and proponents to use their discretion in applying the most appropriate air dispersion model. Section 5(2) of O. Reg. 346 states: "The concentration of a contaminant at a point of impingement ***may*** be calculated in accordance with the Appendix". Use of the word ***"may"*** (as opposed to "shall" for example) allows MOE and proponents discretion to select the most appropriate air dispersion model to assess maximum ground level concentrations from a facility. This discretion is important particularly when an abatement issue has been identified, and all parties have an interest in using the best scientific tools available to assess environmental and health impacts. Once the new models are phased-in, they would be used for both the approvals process and for assessing compliance with MOE's air quality standards.

Decision Box 3.2: Managing in the Interim

3.2 Proposal for discussion:

During the phase-in period, for the C of A process, MOE will accept model results using either the new models or the O. Reg. 346 models for comparisons with the air quality standards. For abatement and/or compliance assessment purposes (which could be linked to the approvals process), MOE will continue to exercise its discretion on which model should be used to assess the likelihood of environmental and/or health impacts. Once the new models are phased-in, they would be used for both the approvals process and for compliance assessment purposes.

Questions for stakeholders:

3.2.1 What other issues should MOE consider while managing in the interim?

[5] For certificate of approval applications where odour is an issue, the Environmental Assessment and Approvals Branch (EAAB) requires proponents to use a model that considers all dispersion conditions. Hence, for odour impact assessments, the US EPA models will continue to be used.

3.3 Using simple screening methods (A Tiered Approach)

A tiered approach to assessment will minimize resource impacts for all those impacted by the introduction of the new models. MOE proposes to set up a series of conservative screens or a tiered approach (based on worst case scenarios) to assess contaminant concentrations against MOE air quality standards. Initial screens would make conservative assumptions about on-site meteorological conditions and contaminant concentrations. A proponent can then assess their emissions under these worst case conditions, and if they meet the screen (i.e. the POI), know that they are well within the MOE air quality standards. More refined modelling techniques would need to be applied each time a successive screen showed an exceedance of MOE air quality standards. The last screen or tier would require the most sophisticated or refined modelling techniques, and would be the most representative of actual on-site conditions and contaminant concentrations.

Figure B outlines the proposed MOE screening methods. Tier 1 involves the US EPA SCREEN3 model which requires no meteorological data. This model is normally used as an initial screening tool to assess single sources of emissions. SCREEN3 can be applied to multi-source facilities by conservatively summing the maximum concentrations for the individual emission sources. Screening assessments for multiple emission sources can also be performed with the US EPA new models such as ISC-PRIME and AERMOD by using a "worst case" meteorological data set that is repeated for a full range of wind directions (Tier 2). Alternatively, these models can be run using regional meteorological data sets (Tier 3). The most representative modelling scenario would be using the most refined modelling technique with local meteorological data (Tier 4) to assess contaminant concentrations.

MOE would provide the worst case data set (used in Tier 2) as well as the regional meteorological data sets (used in Tier 3). Local meteorological data (used in Tier 4) would be provided by the proponent and/or agreed to by MOE. A more refined modelling assessment would allow proponents to use effects-based standards with appropriate averaging times to assess environmental and health impacts (see Section 3.5). This means that for facilities where emissions occur for only part of the day or vary significantly during the day, emission rates for the actual operating times could be used in assessing compliance with effects-based air quality standard over the appropriate averaging time (i.e. 24 hour health-based criteria) rather than the screening level POI standard.

Any proponent may choose to go directly to the more refined modelling techniques (Tier 3 or 4) and skip the initial Tier 1 or 2 of the proposed screening methods if they so choose. For more details on the proposed tiered approach, please see Appendix A (Outline for an "MOE Air Dispersion Modelling Guide", Section A.2,)

Decision Box 3.3: A Tiered Approach

3.3 Proposal for discussion:
In order to expedite the review process and minimize impacts for stakeholders, MOE proposes to use a series of conservative screens to assess compliance. A four tiered approach is suggested which begins with screening level models to assess compliance against the 1 hour POI criteria and ends with more refined modelling assessments to determine compliance with effects-based standards with appropriate averaging times (see Section 3.5). Proponents would have the option to demonstrate compliance with either the "screening level" POI (1 hour criteria) or the effects-based standard(s) with appropriate averaging times (see Section 3.5).

Questions to stakeholders:

3.3.1 Is the four tiered approach to assessing compliance with air quality standards outlined in Figure B acceptable? (see also Appendix A, Section A.2)

3.4 Discussing background ambient air concentrations

Some jurisdictions require emitters to add background concentrations to modelled POI concentrations in assessing the total air concentrations near a facility. For most contaminants in Ontario, background concentrations are much less than the air quality standards. Normally, MOE requires emitters to include contributions from background sources only when MOE considers them to be significant. For more information on background concentrations, please see Appendix A (Outline for an "MOE Air Dispersion Modelling Guide", Section A.9).

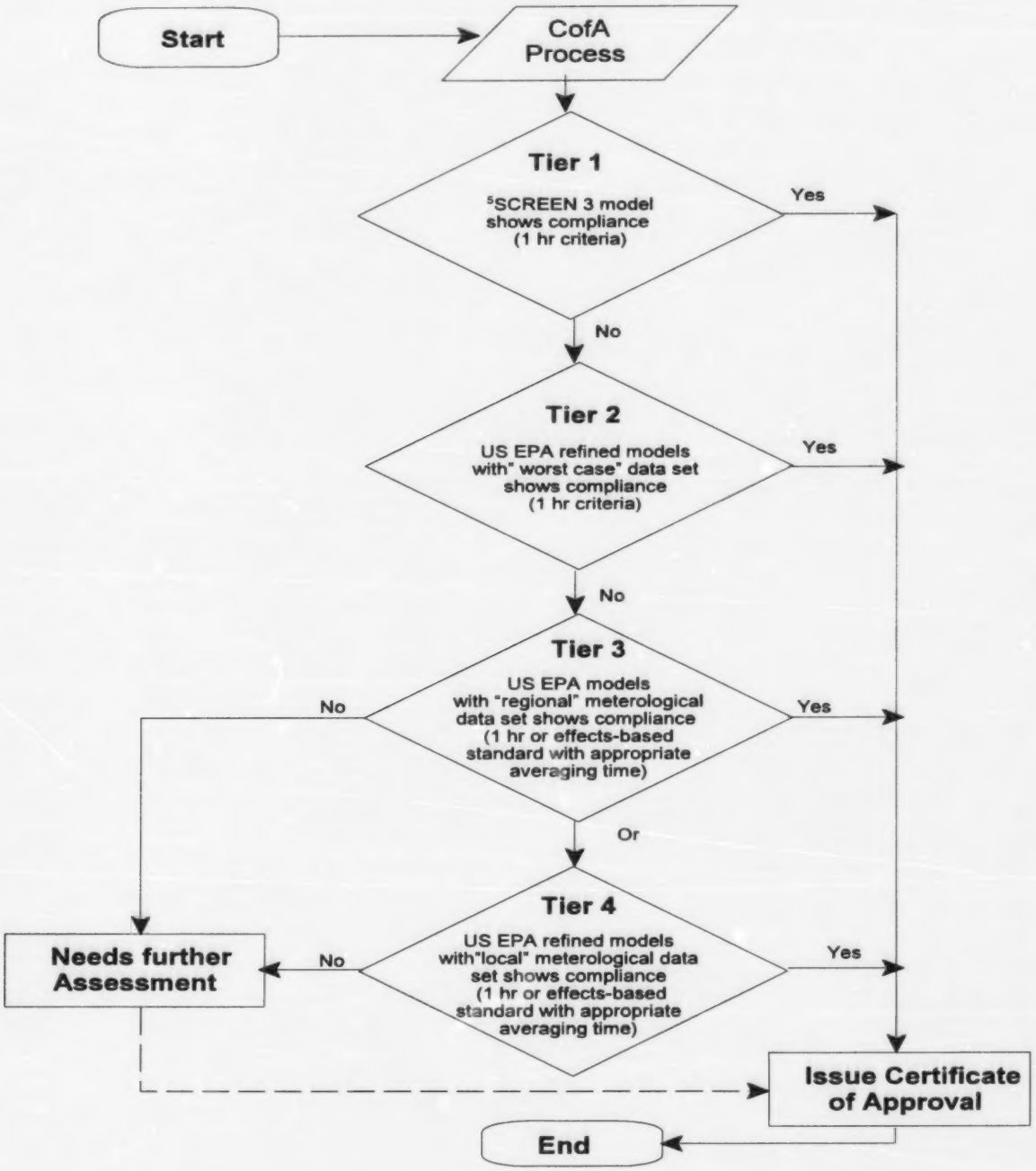
Decision Box 3.4: Discussing background concentrations

3.4 Proposal for discussion:
MOE will continue to consider adding background concentrations to modelled results depending on the contaminant being emitted and whether or not the contribution would be considered significant.

Question for Stakeholders:

3.4.1 Is this approach acceptable?

Figure B A Tiered Approach to Assessing Air Quality Standards


Start
CofA Process
Tier 1
[5]SCREEN 3 model shows compliance (1 hr criteria)
Yes
No
Tier 2
US EPA refined models with" worst case" data set shows compliance (1 hr criteria)
Yes
No
Tier 3
US EPA models with "regional" meterological data set shows compliance (1 hr or effects-based standard with appropriate averaging time)
No
Yes
Or
Tier 4
US EPA refined models with"local" meterological data set shows compliance (1 hr or effects-based standard with appropriate averaging time)
No
Yes
Needs further Assessment
Issue Certificate of Approval
End

5 A screening model version of AERMOD is currently under development and would likely replace SCREEN3 by the time the phase-in period was over.

3.5 Introducing effects-based averaging times

A key advantage to introducing the new air dispersion models is the ability to use effects-based standards with appropriate averaging times to assess compliance. Effects-based averaging times means that a contaminant could be assessed using modelled exposure concentrations over the most appropriate averaging period for that contaminant. For example, the effects-based averaging time for health-based air standards is 24 hours (or daily) exposure; the effects-based averaging time for odour-based compounds is considered to be 10 minutes. The proposed new air dispersion models allow for an assessment of the air standards using the most appropriate averaging time for that contaminant. The new models can calculate concentrations from 1 hour up to 1 year. The ability to model concentrations using appropriate averaging times provides a more representative assessment of health and environmental impacts from air emissions.

With the existing O. Reg. 346 models, assessment of a facility is done by using the maximum ½ hour emission rate and comparing that to a conservative screening level concentration or POI. If a facility meets the screening level or maximum ½ hour POI, then it is likely to meet the effects-based standard with the appropriate averaging time concentration. The proposed new models allow for an assessment of the air standards using the most appropriate effects-based averaging time for that contaminant. This means, for example, that for facilities where emissions occur for only part of the day or vary significantly during the day, emission rates for the actual operating times could be used in assessing compliance with the most appropriate effects-based air quality standard (i.e. a 24 hour health-based air standard). Allowing for an assessment of air quality standards using a more appropriate effects-based averaging time means the new models provide a more representative assessment of emissions and health and environmental impacts from a facility as opposed to using the more conservative POI screening levels concentrations at ½ hour or 1 hour maximum emission rates.

MOE proposes to introduce effects-based standards with appropriate averaging times into O. Reg. 346 as regulatory standards. The proposal is to include, where they are known, all effects-based standards with appropriate averaging times for contaminants. For example, if a contaminant has both a 10 minute odour-based standard as well as a 24 hour health-based standard, both would be included in the regulation. The traditional screening levels or the maximum 1 hour concentrations (the maximum ½ hour concentrations would continue to be used during the phase-in period), would still be used as a screening tool in Tier 1 and Tier 2 assessments (see Figure B).

A sample format of the proposed revisions to Schedule 1 of O. Reg. 346 is included in Appendix C. Table C-1 (Screening Levels) and Table C-2 (Effects-based Averaging Times) is an illustration of the proposed two new schedules to the regulation. Each of these proposed new schedules includes a phase-in period for new or revised air quality standards.

The implementation date proposed is consistent with the proposed phase-in period for new air quality standards that is outlined in the discussion paper: "A Proposed Risk Management Framework for the Air Standard Setting Process in Ontario" dated March, 2001. The new proposed schedule(s) and the introduction of new air dispersion models will provide options to facility operators by allowing compliance with **either** a screening level component of the air quality standard (POI) or with the effects-based standard with the appropriate averaging time. For more details on the introduction of appropriate averaging times, please see Appendix A (Outline for an "MOE Air Dispersion Modelling Guide", Section A.3 and A.8).

Decision Box 3.5: Introducing Effects-based Averaging time concentrations

3.5 Proposal for discussion:

Upon introduction of the new air dispersion models into Ontario, MOE proposes to formalize the use of effects-based standards with appropriate averaging times into O. Reg. 346. For screening modelling assessments, maximum 1 hour average emission rates would be used (similar to existing ½ hour maximum emission rates used with existing models). However, when performing refined modelling assessments, effects-based standards with appropriate averaging times could be used (see Appendix A, Section A.3). MOE proposes to amend O. Reg. 346 by replacing the existing Schedule 1 of the regulation with two new tables or schedules. The proposed format of these two new tables are included in Appendix C for discussion.

Questions to stakeholders:

3.5.1 Should MOE formally introduce the concept of effects-based standards with appropriate averaging times into the regulation for compliance assessment?

3.5.2 Should multiple effects-based averaging time concentrations for contaminants (where they are known) be included in the regulation (i.e. odour as well as health-based standards with appropriate averaging times)?

3.6 Applying statistics to modelling

Air dispersion models provide a good indication of whether or not there is likely to be an exceedance of an air quality standard at a particular location. US EPA modelling studies have shown a good correlation between the concentrations predicted by the models and actual measured concentrations. One of the features of the new air dispersion models is that, if prompted, the model can output when an exceedance is likely to occur, and how often it will occur for various averaging times. US jurisdictions as well as the province of Alberta, use this information to allow proponents to assess compliance with certain contaminants using the x^{th} highest concentration in a year as opposed to the maximum concentration predicted by the model. MOE is proposing that, under a more refined modelling scenario (i.e. the type of assessment that would occur in Tier 4 of the screening methods outlined in Figure B), compliance with certain air standards could be compared to the x^{th} highest concentration as opposed to the maximum concentration predicted by the model. This approach of using the x^{th} highest concentration to assess compliance, ***for modelling purposes only***, may be acceptable for specific air contaminants where the air quality standard is based on chronic impacts (over a lifetime of exposure) or odour-based thresholds, for example, and there are no known acute health effects. In the US, some ambient air standards are stated as not to be exceeded more than once a year.

MOE proposes to allow the use of the x^{th} highest concentration for specific compounds where the basis of the air quality standard allows for this discretion. MOE would provide the list of contaminants where it is acceptable to apply this statistical concept in a Tier 4 assessment. MOE is also willing to discuss the application of a cap on x^{th} highest concentration to address any potential for acute or other unknown impacts. For more details on assessing compliance with the x^{th} highest concentration, please see Appendix A (Outline for an "MOE Air Dispersion Modelling Guide", Section A.10).

Decision Box 3.6: Applying statistics to modelling

3.6 Proposal for discussion:

Depending on the contaminant and the effects-based averaging time concentration for that contaminant, MOE is willing to consider, *for modelling purposes only*, that compliance with an air quality standard be based on a the x^{th} highest concentration as opposed to the maximum concentration predicted by the model. This approach would be limited to contaminants where the basis for the standard was odour or chronic health or environmental effects and where there are no known acute impacts.

Questions for stakeholders:

3.6.1 Should MOE accept, *for modelling purposes only*, an evaluation using the x^{th} highest concentration for assessing compliance with specified air quality standards?

3.6.2 If so, what x^{th} highest concentration should be permitted?

3.6.3 In order to protect against known acute impacts or other unknown environmental impacts from contaminants, should MOE consider capping the allowable difference between the highest concentration and the x^{th} highest concentration? (i.e. the difference between the x^{th} highest concentration and the highest modelled concentration cannot exceed y % of the air quality standard). If so, what should that cap be?

3.7 Ensuring Consistent use of Models

Introducing the improved mathematical models into Ontario is a positive step towards improving the knowledge of environmental and health impacts from air emissions. The goal is to apply the models consistently within and across all sectors. Consistent application of the models will be ensured through an amendment of O. Reg. 346 to reflect the changes in air dispersion modelling. MOE proposes to replace the existing appendix to O. Reg. 346 with reference to an MOE "Air Dispersion Modelling Guide" that would outline acceptable air dispersion models for use in Ontario as well as how and when they could be applied. The guide will also allow for use of alternative models where a proponent can demonstrate that an alternate air model is appropriate for their facility. MOE will develop and consult on the "Air Dispersion Modelling Guide" before it is finalized and incorporated into the regulation.

A variety of communications tools may be helpful to ensure consistent application of the models either through the approvals process or when dealing with abatement issues. This may include, but is not limited to, partnerships with various associations and service providers to train industrial stakeholders, ENGOs, and MOE staff; establishing a web site that includes meteorological data sets for use with the models; and ongoing dialogue with MOE to strive for a consistent application of the tools (i.e. posting of Frequently Asked Questions (FAQs) on the web).

Decision Box 3.7: Ensuring Consistent use of Models

3.7 Proposal for discussion:
Amendments to O. Reg. 346 will require that the suite of new models be applied to assess routine air emissions from all regulated emitters in Ontario.

Questions to stakeholders:

3.7.1 What should MOE do to promote consistent application of the models?

3.7.2 What information or communication tools would users need in order to run the models effectively?

3.8 Linkages to the Air Standards Setting Process

The development of air quality standards in Ontario can be sub-divided into two distinct components: Risk Assessment (RA) and Risk Management (RM). The Risk Assessment process reviews the science basis of standards in other jurisdictions plus most recent peer reviewed science to adopt an air standards based on the limiting effect or environmental impact for that compound (e.g. health, odour, etc.). The outcome of the Risk Assessment stage of the standards development process is an effects-based air quality standard. Risk Management is the consideration of time, technical and/or economic issues in the development and/or implementation of new air quality standards.

New air quality standards and/or the introduction of the new air dispersion models could mean a change in the compliance status of some facilities. MOE acknowledges that, if stakeholders made comments on a proposed new or revised air quality standard based on the existing O. Reg. 346 air dispersion models, any changes in the models may lead to changes in stakeholders opinions and comments.

The introduction of the new air dispersion models does not change the science or risk assessment stage of the air standards setting process. However, introduction of the new models could affect the risk management stage for new or revised air quality standards since risk management is the consideration of technical feasibility, economic factors and/or time to implement a new or revised air quality standard. Risk management issues are currently being discussed in a parallel discussion paper: "A Proposed Risk Management Framework for the Air Standard Setting Process in Ontario", dated March, 2001. Any comments regarding risk management issues, which include the implementation of new air quality standards as well as the change over to the new air dispersion models, should be submitted as part of that consultation process.

Decision Box 3.8: Linkages to the Air Standards Setting Process

3.8 Proposal for discussion:

MOE recognizes that stakeholder's comments on a particular air quality standard could change if the proposed air dispersion models were adopted for widespread use in Ontario. Risk Management issues are currently being discussed in a parallel consultation process in the document: "A Proposed Risk Management Framework for the Air Standard Setting Process in Ontario" dated March, 2001. MOE requests that any comments regarding risk management issues, which include the implementation of new air quality standards and the change over to the new air dispersion models, should be submitted as part of that consultation process.

3.9 Identifying other stakeholders issues

Although this discussion paper highlights key areas for discussion with stakeholders, MOE recognizes that there may be other implementation issues that need further discussion with stakeholders prior to introducing the new air dispersion models. Some of the more technical aspects of introducing the new models, such as the requirements for meteorological data, and identification of critical receptors are included for discussion in Appendix A (Outline for MOE "Air Dispersion Modelling Guide").

MOE encourages comments and suggestions from all stakeholder groups.

Decision Box 3.9: Other Stakeholder Issues

Questions for stakeholders:

3.9.1 As part of this consultation, MOE will discuss with stakeholders the development of an MOE "Air Dispersion Modelling Guide". Should MOE organize a stakeholder consultation committee to help develop and provide recommendations on the proposed guide?

3.9.2 Are there any other issues that MOE should consider in the formal introduction of the new air dispersion models into Ontario?

4.0 What happens now?

MOE proposes to formally adopt for use in Ontario the suite of US EPA air dispersion models. This discussion paper has outlined an explanation of why MOE should adopt the more current US EPA air dispersion models (Section 2.0); the key issues for discussion with stakeholders (Section 3); a technical outline of what is being proposed (Appendix A); answers to Frequently Asked Questions (FAQs) (Appendix B); and the introduction of effects-based standards with appropriate averaging times into O. Reg. 346 (Appendix C).

The results from this consultation will be used to develop an MOE "Air Dispersion Modelling Guide". Stakeholders will have another opportunity to comment on the draft technical guide once it is developed and before it is finalized. The comment period for this discussion paper is 120 days from the date it was posted on the **Environmental Registry.** Please submit your comments to:

Ministry of the Environment
Standards Development Branch
Attention: Cathy Grant, Engineer Specialist - Air Pollution
40 St Clair Ave West, 7th floor
Toronto, Ontario
M4V 1M2
Telephone Number: (416) 327-6600
Fax: (416) 327-2936
email: sdb-ebr@ene.gov.on.ca

Appendix A

Outline for MOE

"Air Dispersion Modelling Guide"

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Introduction to MOE Modelling Guide

The existing air dispersion models are outlined in an appendix to O. Reg. 346. These O. Reg. 346 models have been in place for over 30 years. MOE proposes to replace this appendix to the regulation with an MOE Air Dispersion Modelling Guide (the "modelling guide") that would outline acceptable air dispersion models for use in Ontario as well how and when they could be applied. The Ministry of Environment (MOE) is proposing to adopt the suite of US EPA air dispersion models for widespread use in Ontario. The US EPA Notice on Proposed Changes to the suite of air dispersion models can be found in Part 51, Chapter 1, title 40 of the Code of the Federal Register (CFR), Appendix W to Part 51 – – GUIDELINE ON AIR QUALITY MODELS, www.epa.gov/ttn/scram/) which includes Appendix A - Summary of Preferred/Recommended Models.

There are a number of reasons why Ontario is proposing to replace the existing models in O. Reg. 346 and adopt the US EPA preferred air dispersion models. The existing O. Reg. 346 models do not consider a full range of meteorological dispersion conditions while the US EPA preferred models do consider a full range of dispersion conditions. The US EPA models include more recent science and thus provide more realistic treatments for a number of processes that affect dispersion. The largest differences in modelling results between the existing O. Reg. 346 model and US EPA models generally occur for: 1) low exit velocity vents and short stacks; or 2) very tall stacks. Adopting the new models will mean a more realistic assessment of POI or ground level concentrations and the ability to use effects-based standards with appropriate averaging times.

The US EPA suite of air dispersion models are better assessment tools for predicting Point of Impingement (POI) concentrations. Of the current US EPA model suite, the most commonly used air dispersion models are SCREEN3 and the US EPA Industrial Source Complex model version 3 (ISC 3). However, the US EPA is in the process of adopting the next generation of air dispersion models to replace ISC3, namely AERMOD and ISC-PRIME. It is this next generation of dispersion models, AERMOD and ISC-PRIME, along with other appropriate models from the US EPA suite, that MOE is proposing to adopt for widespread use in Ontario.

Technical Issues for Consultation on the Proposed MOE Air Dispersion Modelling Guide

The following are issues which will be discussed during the consultation on developing an MOE Air Dispersion Modelling Guide (or "modelling guide"). The technical components of a modelling guide can be considered in three general categories.

1) The modelling guide would list preferred models. Some alternative models could be listed in the guide along with a description of the information required to support the use of an alternative model. Guidance on the intended application of the models would also be included in this section of the document.

2) A description of how screening modelling assessments and refined modelling assessments could be used in a tiered approach to assessing compliance with MOE standards would be part of the MOE modelling guide.

3) The modelling guide would also describe the input requirements for running the models, how model results should be compared with the MOE air quality standards and what information should be included in an approvals application.

A.1 Regulatory Models

The United States Environmental Protection Agency (US EPA) maintains a list of preferred air quality models. They are in the process of introducing new models for this list which include state-of-the-art modelling concepts. The AERMIC committee (American Meteorological Society/Environmental Protection Agency Regulatory Model Improvement Committee) is the group who are now finalizing the new generation model AERMOD.

Currently, the most frequently used of the US EPA preferred air quality models is the Industrial Source Complex Model (ISC3). This model can handle emissions from a wide variety of sources including emissions from stacks, sources affected by building downwash, volume sources and area sources. It is recommended for use in urban or rural areas for flat or rolling terrain. Since this model can be run with an hour by hour meteorological data set it can calculate concentrations for 1 hour to annual averaging times.

Although the ISC3 model can be used in complex terrain it tends to give very conservative answers in these cases. The Complex Terrain Dispersion Model (CTDMPLUS) is a US EPA preferred model for application to elevated point sources in complex terrain. This model can also calculate 1 hour to annual average concentrations.

The dispersion algorithms in ISC3 and CTDMPLUS have been incorporated into the screening models SCREEN3 and CTSCREEN, respectively. These screening models search through a preset range of meteorological conditions and select the conditions that give maximum 1 hour average concentrations. Using conservative scaling factors, estimates of likely maximum longer averaging time period concentrations (i.e., 3 hour, 8 hour, 24 hour or annual averages) can be derived from these model simulations. Although the SCREEN3 model treats only one source at a time, it can be conservatively applied to multi-source facilities by adding the individual maxima together. All of the above dispersion models along with associated preprocessor programs and their User's Guides can be obtained at no charge from the US EPA modelling web site www.epa.gov/ttn/scram/.

US EPA has proposed changes to its modelling guide document which includes the replacement of the ISC3 model with new updated models. Their proposal included a 1 year phase-in period for the new models. The US EPA Notice of Proposed Changes to their modelling guideline document and list of preferred models along with proceedings from the 7th Modeling Conference where the proposed model changes were presented can be obtained from the US EPA modelling web site.

US EPA has proposed AERMOD as a new platform for regulatory steady-state plume modelling. The modelling system has 3 components: AERMOD - the air dispersion model; AERMET - the meteorological data preprocessor; and AERMAP - the terrain data preprocessor. AERMOD includes major improvements in planetary boundary layer turbulence formulations and in the treatment of dispersion in complex terrain. The modelling system along with model evaluation results and a consequence analysis of the model differences between AERMOD, ISC3 and CTDMPLUS were presented at the 7th Modeling Conference.

US EPA has proposed that AERMOD be used for most regulatory applications including simple and complex terrain.

The major dispersion process which was not updated in AERMOD was the building downwash algorithm. A parallel model development effort to update the downwash algorithms in ISC3 produced the ISC-PRIME model. This model includes all of the features in ISC3 (including dry and wet deposition). In their Notice on Proposed Changes, US EPA has recommended that ISC-PRIME be used for cases where building downwash or dry deposition are a major concern.

Most of the reviewers and commentators at the 7th Modeling Conference strongly recommended that the PRIME downwash algorithm be incorporated into AERMOD. US EPA have agreed to have this work done. They indicated in their Notice of Proposed Changes that this work could take up to 12 months.

The association representing US state and local air pollution regulatory agencies is developing an all terrain screening tool for AERMOD. In the interim period, US EPA has proposed that SCREEN3 and CTSCREEN continue to be used as screening models.

The list of US EPA preferred models includes a number of models for special applications such as line source modelling or modelling emissions and dispersion at airports. These are models which could be used for the particular circumstances for which they were designed on a case-by-case basis.

In addition to their list of preferred models, US EPA also has a list of alternative models. US EPA recommends that alternative models be used only on a case-by-case basis with the agreement of the local air pollution regulatory agency. A summary of US EPA's preferred models is given in Appendix A of their guideline on air quality models. All of the preferred and alternative models can either be obtained directly from US EPA's modelling web site or information on how to obtain them is provided.

MOE is proposing to adopt AERMOD and ISC-PRIME as the preferred models for use in Ontario. Given the time period over which MOE's modelling guide would be developed and the proposed phase-in period from the time the regulation is amended the PRIME downwash algorithm would be incorporated into AERMOD to give one preferred model long before the phase-in period is over.

Decision Box A.1: Regulatory Models

A.1 Proposal for discussion:
MOE is proposing to adopt the US EPA suite of air dispersion models as the preferred models referenced in the MOE modelling guide. Ultimately the preferred models would be AERMOD with the PRIME downwash algorithm incorporated and a screening tool for this model. If these models were not available when the MOE modelling guide is written, then the preferred models could include AERMOD, ISC-PRIME and possibly ISC3 with SCREEN3 and CTSCREEN as interim screening models.

Questions for stakeholders:

A.1.1 **Is the proposal outlined in A.1 above acceptable?**

A.1.2 **What status should alternative models be given in the MOE modelling guide? How should MOE reference the alternative models in the regulation?**

A.2 A Tiered Approach for Assessing Compliance with Standards

Figure B (a Tiered Approach to Assessing POI) in Section 3.4 shows a flow chart depicting the use of screening modelling and refined modelling in a tiered manner. The use of conservative screening models to assess compliance can significantly reduce the resource requirements of a dispersion modelling assessment.

Tier 1 in Figure B refers to the use of the SCREEN3 model. This model searches through a preset range of meteorological conditions to find a maximum hour average concentration. The input information requirements for this model are similar to those for the O. Reg. 346 dispersion models. In both cases, maximum emission rates are used (maximum half hour for the O. Reg. 346 model and maximum 1 hour for US EPA models) with the basic model input being source characteristics and receptor locations. Since SCREEN3 can be run for only one emission source at a time, maxima for model runs with each of a facilities sources could be added together to give a conservative estimate of the overall maximum hour average concentration due to facility emissions. If this assessment shows compliance with a 1 hour POI screening concentration then the Certificate of Approval could be issued.

A SCREEN3 assessment can be quite conservative for facilities with many emission points contributing to the maximum concentration. The maxima for the various emission points could occur under different meteorological conditions, at different distances from the facility and the emissions sources do not necessarily line up in one wind direction.

Tier 2 refers to a second level of screening modelling which uses a US EPA preferred model (currently this is usually ISC3 but as discussed above AERMOD and ISC-PRIME are proposed new models) but run with a "worst case" meteorological data set. The meteorological data set for ISC3 or for ISC-PRIME would search through all stability classes and a range of wind speeds similar to what is done in SCREEN3 but this data is then repeated for a range of wind directions. This multi-source model run would still use the maximum hourly emission rates but would properly account for the combined impact of different emission points at receptor locations for each wind direction. The compliance check would be with a 1 hour average screening POI concentration.

The screening tool for AERMOD (now being developed) would also include a search through meteorological data to find the conditions that give the highest hour average concentrations. The AERMOD screening tool would likely be a multi-source model. This would be equivalent to using the ISC models with a worst case data set as in Tier 2.

In a **Tier 3** assessment, the US EPA model would be run using meteorological data sets developed for various regions in Ontario. Since the modelling in this case requires the use of an hour by hour meteorological data set, comparisons could be made with either the 1 hour average screening concentrations or with the real effect-based averaging time periods (e.g., 8 hour, 24 hour). When

comparisons with effect-based standards with appropriate averaging times are used, then compliance with all standards (with appropriate averaging times) must be demonstrated. If comparisons are made with longer averaging time period standards, then maximum emission rates over the appropriate averaging periods could be used in the assessment rather than the maximum rate for any hour in the time period.

A **Tier 4** assessment as outlined in Figure B deals with cases where other modelling techniques more appropriate to a site and/or more localized meteorological data are used in the assessment. The use of other models or modelling methods could be warranted by factors such as complex building structures, areas with complex wind flows due to topography or effects from nearby water/land boundaries, and unusual source configurations. If local wind and/or turbulence conditions are significantly different from those in a regional meteorological data set, then the development of a localized meteorological data set can improve the assessment of the impacts from a facility's emissions. (See also Section 3.3, Using simple screening methods).

A.3 Model Input Data

Emissions from Source Types

As is done in other modelling guideline documents, this section would include brief descriptions of what is meant by point, line, area and volume sources. The Ministry has produced a guideline document: "Procedure for Preparing an Emission Summary and Dispersion Modelling Report" dated June 1998 which describes how to prepare an emission inventory report for a facility. The procedures outlined in this document would still be used in estimating emission rates.

When screening modelling is being performed with US EPA models, maximum hour average screening emission rates would be used. However, if refined modelling is performed to estimate maximum concentrations for effects-based standards appropriate averaging times, then emissions for the actual operating times could be used in the modelling assessment. For example, if a source had daily emissions during specific operating hours, and the effects-based averaging time was over a 24 hour period, then emission rates would only be entered for the appropriate period of operation and emissions would be set to zero for the rest of the time period. MOE is interested in stakeholders view on this approach. (See Section 3.5, Introducing Effects-based averaging times).

A.4 Meteorological Data

Screening Meteorological Data

The SCREEN3 model uses a preset range of meteorological conditions which are built into the model with concentrations calculated along the plume centreline for single sources. Applying this

model to multi-source facilities can be quite conservative. A screening meteorological data set for use in running the ISC3 or ISC-PRIME models can be developed by including a range of meteorological conditions similar to those used in SCREEN3 but repeated for a range of wind directions (e.g., 36 wind directions every 10°). A screening modelling assessment using this data set would allow the impacts of the various emission sources on a facility to be combined in a realistic manner. For screening assessments with AERMOD, a screening tool including an appropriate range of meteorological conditions is being developed by the organization representing US air pollution control agencies. This would be equivalent to using the ISC models with a worst case data set as outlined in Tier 2.

MOE is proposing to develop a number of regional meteorological data sets which could be used when assessing a facility's impacts. To ensure that model results capture maximum concentrations over averaging times from 1 hour to annual averages, MOE is proposing that 5 years of regional meteorological data be used. This data set length is consistent with US EPA requirements.

For cases where local wind and/or turbulence conditions differ significantly from those in regional meteorological data sets, refined modelling assessments (Tier 4) would require the best available local meteorological data. Localized data could be site specific meteorological data or it could be the most representative data available from nearby airports, MOE or other organizations. Since a number of wind data sets are only reported to the nearest 10 degrees, most meteorological preprocessors include a means of randomly assigning wind directions within the 10 degree sectors.

An additional factor that affects dispersion in ISC3 and ISC-PRIME is the designation of the site as being an urban or a rural setting since different dispersion coefficients are used. The US EPA recommended method for designation of a site as primarily urban or rural is examining land use within a 3 km radius of a site. Population density averaged over a 3 km radius is an alternative criteria but it can be misleading for an industrial or commercial area.

For AERMOD which has a more advanced meteorological preprocessor, information on surface characteristics such as surface roughness are required. References providing information on how to select appropriate values for these parameters would be provided in the modelling guide document. AERMET, the meteorological preprocessor for AERMOD, allows these surface parameters to be input as a function of wind direction.

Decision Box A.4: Meteorological Data

A.4 Proposal for Discussion

MOE is proposing that screening meteorological data sets will be developed to allow multisource assessments for comparisons with 1 hour average screening concentration limits. A number of 5 year long regional meteorological data sets would provided by MOE for use in assessing the impacts of facility emissions. These data sets would be made publicly available. For refined modelling assessments in Tier 4, meteorological data sets using the most representative local data would be developed by the proponent and/or agreed to by MOE.

Questions for stakeholders:

A.4.1 Is MOE's proposal to provide screening meteorological data sets appropriate?

A.4.2 Is MOE's proposal of providing regional 5 year meteorological data sets appropriate?

A.5 Receptor Locations

The locations and densities of receptors are chosen to identify where maximum concentrations will occur and to provide concentration estimates at sensitive locations such as schools, hospitals, apartments and houses. The location and spacing of receptors depends on the source characteristics and the number of sources that could significantly contribute to the combined off property concentrations.

Model simulations with SCREEN3 (or the screening tool for AERMOD which is being developed) could be used to identify which of the facility's sources could have significant contributions to the overall maximum concentrations and the distances out to which the contributions were large. For cases with only a couple of dominant emission sources, polar receptors centred at each of the 1 or 2 major sources could be used in Tier 2 modelling which uses a worst case search meteorological data set with fixed wind directions. Polar receptors would then be located along the centrelines of the major sources. The maximum distance for receptors could be estimated from SCREEN3 model results.

For facilities with many sources contributing to maximum concentrations and for Tier 3 and 4 assessments, either a rectangular grid or a combination of polar receptors and rectangular grids would be recommended. Receptors along the facility's property line are also needed if emissions from short stacks or emissions affected by building downwash can impact close to the facility.

Input from stakeholders on the extent to which specific prescriptive guidance on the spacing of receptors is welcomed as part of this discussion paper. In general, receptors can be spaced farther apart at greater distances from the facility. The results of screening analyses can provide information on grid spacing required at various distances from a facility. Typically, grid spacing of about a tenth of the distance from the emission source is adequate (e.g., a 20 m spacing for receptors within 200 m of a facility). The models could also be run in two stages with a comparatively course grid to identify where the combined effects of a facility's emissions are largest with a finer resolution grid model run performed for the area where maxima occur.

Decision Box A.5: Receptor Locations

A.5 Proposal for discussion

The identification of critical receptors is an important component of good dispersion modelling. Input from stakeholders on the extent to which specific prescriptive guidance on the spacing of receptors is welcomed as part of this discussion paper.

Questions for stakeholders:

A.5.1 What type of guidance and detail is needed in the MOE modelling guide on how to set up receptor locations for model simulation?

A.6 Good Engineering Practice Stack Heights

Good Engineering Practice (GEP) Stack Heights are the stack heights that US EPA requires to avoid having to consider building downwash effects in dispersion modelling assessments. The definition of GEP is stack heights equal to the building height plus 1.5 times the smaller of the building height or width. The US EPA modelling guideline document prohibits the use of stack height credits in excess of the Good Engineering Practice stack height when using dispersion models to assess emission limits for the source.

Decision Box A.6: Good Engineering Practice Stack Heights

A.6 Proposal for Discussion:
MOE will consult on the possibility of limiting the stack heights to the Good Engineering Practice stack heights for dispersion modelling assessments.

Questions for stakeholders:

A.6.1 Should MOE adopt the US EPA approach of not allowing more than Good Engineering Practice stack height for modelling purposes only?

A.6.2 Should this be limited to new sources only or for new and existing sources?

A.7 Inclusion of Buildings and Structures in Model Simulations

Turbulent downwash caused by the wind flowing over buildings and structures must be taken into account in model simulations. In defining Good Engineering Practice (GEP) Stack Heights, US EPA considers that building downwash can occur for stack heights up to 2.5 times the height of the building or structure at the location of the stack or nearby structures (or the height plus 1.5 times the smaller of the height or the width of the structure). This definition is used to determine if downwash should be considered in the ISC3, ISC-PRIME and AERMOD models.

The US EPA model guides describe the influence of nearby buildings or structures as extending out to 5 times the smaller of the width or the height of the structure when the structure is upwind of the emission source. The region of influence of a structure is smaller if it is downwind or to the side of an emission source.

Depending on the wind direction it is possible to have several buildings or different tiers on the same building affect downwash at a stack. For these cases, the building with the largest downwash effect is chosen to give the height and width used in the downwash calculations. The height and width used in downwash calculations can vary with wind direction. Preprocessor programs are available from the US EPA modelling web site to determine appropriate building heights and widths for 36 wind directions for each of a facility's emission sources. Information on the location and sizes of buildings and the location and release heights of emissions are inputs to these programs.

For screening modelling assessments for single sources using SCREEN3, the largest building height that could affect stack downwash is usually used. The maximum and minimum horizontal dimensions of the structure are also needed as input to this model. If a Tier 2 screening assessment using a worst case search meteorological data set is performed using one of US EPA's models,

then the building information could be derived using the building preprocessor programs. To reduce the time in setting up a job run input file for a Tier 2 screening assessment, conservative data for the building dimensions could be used. As is done with SCREEN3, using the largest building height that could affect stack downwash would be the conservative assumption.

MOE is proposing that the MOE modelling guide provide descriptions of how buildings and structures are used as input in US EPA models. More detailed information on inputting building data to preprocessor programs can be found on US EPA's modelling web page. For screening modelling assessments rectangular building structures could be used with the building dimensions chosen conservatively.

A.7.1 Complex Terrain

US EPA has defined complex terrain as cases where the terrain is higher than the stack height. Prior to the development of the all terrain model AERMOD, CTDMPLUS was the recommended model for complex terrain. For terrain less than the stack height, a conservative terrain algorithm in ISC3 has been used. The terrain algorithms in AERMOD provide a more realistic treatment of the impact of plumes on terrain features. For cases where the terrain is gently sloping, the wind flow in AERMOD will follow the terrain resulting in air concentrations nearly the same as in flat terrain.

The factors that need to be considered when deciding if terrain should be included in the model simulation are the gradient of terrain height with distance from the source, the height of terrain features compared to the stack height and how far away the terrain features are from the source. For taller stacks, terrain features a significant distance from the source can still result in high concentrations under very stable conditions. Screening model runs with SCREEN3 for terrain features less than the source height and CTSCREEN for terrain above the source height can show whether or not terrain has the potential of significantly increasing maximum concentrations and how distance from the source affects the results. An all terrain screening tool for AERMOD is being developed by the organization representing US state and local air pollution control agencies. When this model is ready, it would be the preferred model for screening assessments where terrain is a potential concern.

Criteria on terrain sizes and terrain slopes, below which terrain does not need to be considered, could be given in this section of the model guide document. For example, for gently sloping terrain with elevations rising at less than a 5% (or possibly 10%) grade away from the source the flow would follow the terrain.

A.8 How Model Results would be compared to MOE Standards

When screening modelling assessments are performed, the maximum modelled hour average concentrations would be compared with 1 hour average screening standards. During the phase-in period when the current O. Reg. 346 model is still in use, half hour average screening standards would continue to be listed in a screening level table.

Appendix C gives an example of how MOE is proposing that revised Schedule 1 to O. Reg. 346 could appear. Table C-1 of the schedule would list screening level standards for contaminants. These are the maximum half hour average screening standards for use with the current O. Reg. 346 model and maximum 1 hour average screening standards for comparison with results from US EPA dispersion models. The screening half hour or hour average standards are derived starting from effects-based standards as given in examples listed in Table C-2 in Appendix C. For a contaminant with more than one effects-based standard (e.g., odour and chronic health effects), then the screening level is based on the most stringent of the effects-based standards. If a Tier 1 or Tier 2 screening assessment produces maximum concentrations lower than screening level standards then a C of A could be issued.

The effects-based standards given as examples in Table C-2 of Appendix C can be listed for various averaging times. For example a chronic health based standard could have 24 hour (or daily) averaging time while an odour based standard could have a 10 minute averaging time. Other effects-based averaging times could occur from 1 hour to an annual average.

When Tier 3 or Tier 4 modelling is performed using an hour by hour meteorological data set, maximum concentrations can be derived for averaging times from 1 hour to an annual average. Modelled maximum concentrations could then be compared with effects-based standards using averaging times such as those in Table C-2 of Appendix C. For a contaminant with more than one effects-based averaging time standard, model results from Tier 3 or Tier 4 assessments must show compliance with all effects-based standards.

A.8.1 Numerical Factors/Ratios Relating Concentration Maxima at Different Averaging Times

US EPA has listed numerical factors which can be used to estimate maximum longer averaging time concentrations starting from a modelled maximum hour average concentration. These are given in the US EPA document "Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised" (EPA-454/R-92-019) for simple terrain situations. The factors were selected based on experience with elevated point sources with a degree of conservatism included to provide reasonable assurance that maximum concentrations will not be underestimated. The values they list as factors to multiply the maximum 1 hour average concentration are:

Averaging Time	Multiplying Factor
3 hours	0.9 (±0.1)
8 hours	0.7 (±0.2)
24 hours	0.4 (±0.2)
Annual	0.08 (±0.02)

In the US EPA document, the ranges in the numerical factors were attributed to possible variations due to the source characteristics or terrain effects. In a recent addendum to the screening document, US EPA recommended that a multiplying factor of 1 be used out to 24 hour averages for calculations dealing with receptors close to large area sources. When US EPA developed a screening version of the complex terrain model CTDMPLUS , they recommended multiplying factors for that model at 3 hour, 24 hour and annual averages that are lower than those given above.

The half hour average screening POI standards in Schedule 1 of O. Reg. 346 were in many cases derived using numerical factors that are consistent with those recommended by US EPA in their screening document. The factors that have been used to multiply effects-based averaging time criteria to derive half hour POI standards were:

Effects-based Averaging Time	Multiplying Factor (for ½ hour POI)
1 hour	1.2
8 hour	2
24 hour	3
Annual	15

For example, the reciprocal of the US EPA 1 hour to annual average multiplying factor is 1/0.4 = 2.5. Multiplying by 1.2 to convert from an hour to half hour gives 2.5 x 1.2 =3 which is the usual factor MOE has used to multiply a 24 hour average criterion to derive a half hour average POI standard.

During the time period where the proposed table of both half hour and 1 hour average screening standards has not been produced, screening comparisons would be made with the half hour average screening POI standards. For cases when a US EPA model has been run to estimate a maximum 1 hour average concentrations, MOE is proposing to multiply that concentration by 1.2 to estimate the maximum half hour average concentration. That is consistent with how the half hour average POI limits were usually derived.

The Duffee, O'Brien and Ostojic (1991) stability dependent formula to convert modelled values to alternative averaging times is:

$$C_0 = C_1 \times (t_1/t_0)^n \quad (1)$$

where
t_1 = the longer averaging time
t_0 = the shorter averaging time
n = the stability dependant exponent (see below)

Stability Class	**n**
A&B	0.5
C	0.33
D	0.20
E&F	0.167

An alternative for estimating a maximum half hour average from a modelled maximum hour average is to use the stability dependent formulations given equation (1).

$$C_{½ \text{ hour}} = C_{1 \text{ hour}} \times (60 \text{ min}/30 \text{ min})^n \quad (2)$$

where: $C_{½ \text{ hour}}$ and $C_{1 \text{ hour}}$ are the maximum half hour and 1 hour average concentrations respectively.

Equation (1) above would use the value of n for the stability that gave the highest modelled 1 hour concentration. To estimate a maximum 10 minute average for odour standards, equation (1) with 10 minutes replacing 30 minutes would be used. Again the value of n would be for the stability class that gave the highest modelled 1 hour concentration.

See also Section 3.5 "Introducing effects-based averaging times".

Decision Box A.8: Numerical Factors/Ratios

A.8 Proposal for Discussion:

MOE is proposing to continue listing half hour screening standards during the phase-in time period when the O. Reg. 346 model can still be used. Hour average screening concentrations would be added once the new models were adopted and Schedule 1 was revised. For an interim time period when only half hour screening standards are available, MOE is proposing that modelled maximum hour average concentrations derived from US EPA models would be multiplied by 1.2 to estimate a maximum half hour average concentration. To estimate a maximum 10 minute average for odour based standards, the formulations from Duffee et. al. (1991) are proposed.

Questions for stakeholders:

A.8.1 In addition to the screening level numbers, MOE proposes to introduce effects-based standards with appropriate averaging times into O. Reg. 346. This means that for compounds where the limiting effect is odour, the ½ hour POI will be converted to a 10 minute effects-based number. The proposed recalculation of the values for the compounds that would be included in the regulation are outlined in Appendix C. Is this approach acceptable to stakeholders?

A.8.2 The screening level value (POI) will continue to be based on the limiting effect for a compound (i.e., odour, health, vegetation, etc.). MOE proposes to add all known effects-based standards with appropriate averaging times into O. Reg. 346 as outlined in Table C-2. This means that compound could have a screening level value, as well as a 10 minute odour-based standard and a 24 hour health-based standard. This approach would allow for a more accurate assessment of impacts during a more refined modelling assessment. Is this acceptable to stakeholders?

A.9 Background Air Concentrations

Background concentrations can come from both nearby facilities emitting the same contaminants and from area, natural and other sources. Some jurisdictions require that background concentrations be included in assessing the total air concentrations near a facility. For cases where existing nearby facilities emit the same contaminants, explicit dispersion modelling of these sources is required under US EPA's modelling guideline. Monitoring data can then be added to the modelled maximum concentrations to estimate the total air concentrations.

Examples of how other jurisdictions include background air concentrations for isolated sources and for cases with neighbouring facilities are given in US EPA's modelling guideline and Alberta

Environment's Air Quality Modelling Guideline (October, 2000), (www.gov.ab.ca/env/air/airqual/airmodelling.html).

MOE is looking for input from stakeholders on the inclusion of background concentrations in the MOE modelling guide and how background could be added to model results. See also Section 3.4, "Discussing background concentrations".

A.10 Assessing Compliance the x^{th} Highest Concentrations

Some jurisdictions consider assessing compliance using other than the single highest modelled concentration. The Alberta Environment's "Air Quality Modelling Guideline (October, 2000)", (www.gov.ab.ca/env/air/airqual/airmodelling.html) recommends that the highest eight 1 hour predicted average concentrations each single year should be disregarded when comparing model results with certain standards.

In the US, some ambient air standards are stated as not to be exceeded more than once a year. In both the US and in the Canada wide standard setting process, the 24 hour standard for $PM_{2.5}$ is given as the three year average of the 98th percentile of the daily average concentrations.

When dispersion models are run with hour by hour meteorological data sets as in Tier 4 assessments, it is possible to determine a distribution of concentrations rather than just the single highest concentration. MOE is considering allowing the application of statistics such the x^{th} highest modelled concentration in a year. The application of this statistical measure of compliance could depend on the particular contaminant being assessed and/or the averaging time(s) under consideration.

Stakeholder input on the allowance of compliance assessments with a modelled x^{th} highest concentration in a year is being solicited during this consultation. Input on the possible ways of applying a statistical compliance allowance are also welcomed (see also Section 3.6, "Applying statistics to modelling).

A.11 Information for Inclusion in an Approvals Application

A MOE Modelling Guide would be prepared to be consistent with other MOE publications such as the:

- "Guide for Applying for Approval (Air), Section 9 , Environmental Protection Act, R.S.O. 1990"
- "Guide for Applying for Approval (Air): Noise and Vibration, November 1995 (Revised April 1998)"
- "General Information, Certificates of Approval (Air), Section 9 , Environmental Protection Act, R.S.O. 1990, Chapter E-19"
- "Procedure for Preparing an Emission Summary and Dispersion Modelling Report" and "Guide, Application Costs for Air Emissions, s.9, Environmental Protection Act"

The "MOE Air Dispersion Modelling Guide" would be have to be very clear on issues such as:

- Surface Roughness (Rural vs Urban)
- Local Buildings and use of Building Profile Input Program (BPIP) for major on-site buildings
- Receptor Grids
- Terrain Situation (Simple vs Complex) (source of terrain information would be requested where applicable)
- Justification for use of non-regulatory default options
- scaled site plan, with the location of sources, nearby buildings and sensitive receptors, and the modelling coordinates and modelling coordinate system noted
- model methodology must be documented, justification of alternative models (Tier 4) must be provided

The necessary supporting information and justifications for choices made on the above issues would be requested.

MOE would request both hard copy and electronic model input and output files be submitted with the CofA (Air) application. This would include BPIP model files (hard copy and electronic copies), where applicable.

If a Tier 4 was undertaken, the following information is likely to be requested:

- source of meteorological data and documentation outlining the meteorological pre-processing performed;
- if alternative model used, detailed information required to verify model;
- justification of other non-typical model parameters.

Other suggestions are welcome.

Appendix B

"Frequently asked Questions"

Q. What is the purpose of the phase-in period?

A. MOE recognizes that it will take time for users of the air dispersion models to acquire and familiarize themselves with the US EPA suite of models. Although, many in the consulting community and some industry stakeholders are familiar with the US EPA models, many are not. The purpose of the phase-in period is to allow emitters time to assess their state of compliance using the new models and to take appropriate action, if required.

Q. What happens between now and the end of the phase-in period?

A. Once the new models are phased-in, they would be used in the approvals process as wells as compliance assessment in abatement situations. In the interim period, for the approvals process, MOE proposes to accept model results using either the new models or the O. Reg. 346 models for comparisons with the air quality standards. For abatement and/or compliance purposes, MOE will continue to exercise its discretion on which model will be used for assessing the likelihood of health and environmental impacts because in a situation where the impact has been observed, MOE will use the best scientific tools available to be able to assess the impact of those emissions.

Q. Are we going to require new facilities to show compliance with new models or accept O. Reg. 346 models regardless of whether or not it's a new source or existing?

A. If you are building a new facility, MOE would encourage you to use the new air dispersion models to assess compliance against the air quality standards. This will ensure that after the phase-in period elapses, your facility is more likely to be in compliance using the new models. However, during the phase-in period, MOE will accept model results using either the new models or the O. Reg. 346 models.

Q. What if an existing C of A was issued based on an assessment of POI using the O. Reg. 346 air dispersion models and not the proposed US EPA suite of models?

A. Introduction of the US EPA dispersion models into Ontario will not automatically change the status of a company's Certificates of Approval. Existing C of As will still be valid after the introduction of the new models even if they were assessed using the O. Reg. 346 models. However, if and/or when a company identifies a non-compliance situation when assessing their POI concentrations using the new air dispersion models, then they are

obliged under section 13 and if applicable section 14 of the Environmental Protection Act to notify MOE and to take the appropriate action to remedy the situation. This action would likely include, but would not be limited to, discussions with the local MOE district office and an amendment to the C of A to implement the required changes to get that facility into compliance. The purpose of the phase-in period is to allow industry sufficient time to identify any potential non-compliance scenarios and amend their C of As as needed.

Section 13 (1) of the *Environmental Protection Act* states:
"Every person,
(a) who discharges into the natural environment; or
(b) who is the person responsible for a source of contaminant that discharges into the natural environment,
any contaminant in an amount, concentration or level in excess of that prescribed by the regulations shall forthwith notify the Ministry of the discharge."

Section 14 (1) of the Environmental Protection Act states:
"Despite any other provision of this Act or the regulations, no person shall discharge a contaminant or cause or permit the discharge of a contaminant into the natural environment that causes or is likely to cause an adverse effect."

Q. I have equipment that was installed prior to 1970 that has never been modified? Do I even have to comply with the air quality standards in Ontario Regulation 346?

A. Equipment that was installed prior to the promulgation of the *Environmental Protection Act* and that has never been modified does not have to have a Certificate of Approval under Section 9 of the Act. However, compliance with Ontario Regulation 346 and the air quality standards is required (unless specifically exempt under the regulations or Act).

Q. I only have to worry about the new models the next time I apply for a new or an amended certificate of approval right?

A. For business planning purposes, amendments to C of As should not be linked to the introduction of the new models. The Director under Section 9 of the *Environmental Protection Act* does have the authority to amend or revoke a Certificate of Approval at any time. Any facility would be expected to be able to demonstrate compliance with the air quality standards using the new models any time after the phase-in period or before if an abatement/compliance issue was identified. In a situation where the environmental impacts have been observed, MOE will use the best scientific tools available to assess the impact of those emissions. For abatement and/or compliance purposes, MOE will continue to exercise its discretion on which model to use for assessing the likelihood of environmental impacts.

Q. Can I be *required* to use the new models to assess my plant emissions prior to the phase-in period?

A. The existing O. Reg. 346 allows MOE to use its discretion in applying the most appropriate air dispersion model. Section 5(2) of O. Reg. 346 states: "The concentration of a contaminant at a point of impingement ***may*** be calculated in accordance with the Appendix". Use of the word ***"may"*** (as opposed to "shall" for example) allows MOE and the proponents discretion to apply the most appropriate air dispersion model to assess maximum ground level concentrations from a facility.

In the majority of cases to date, and particularly in the Certificate of Approval (Air) process, MOE has used O. Reg. 346 air dispersion models to assess POI concentrations. For abatement/compliance purposes, and where these efforts have been linked to the approvals process, there have been cases where facilities have been requested or required to use the updated new models to assess impacts from air emissions. In situations where environmental impacts have been observed or communicated to MOE, we will use the best scientific tools available to assess the impact of those emissions.

Q. Do all industry have to follow the tiered approach outlined in Appendix B?

A. No. The purpose of the screening methods is to make some conservative assumptions on estimating point of impingement concentrations and if they are within the air quality standards, we know that there is likely to be compliance. However, some facilities may choose to undertake a more realistic modelling scenario (such as Tier 3) to assess their POI concentrations.

Q. I am a good corporate citizen and applied for my C of A using the new air dispersion models. My competitor submitted their C of A application just prior to the phase-in period ending, and got approval based on the O. Reg. 346 models that under predict impacts. Will MOE fix this?

A. During the phase-in period, MOE will promote awareness of the model change over. However, the purpose of the phase-in period is to allow industry to assess their state of compliance using the new models and to take appropriate action. For approvals purposes, a C of A may be issued even though the assessment was undertaken using the O. Reg. 346 models. However, for abatement purposes, MOE has the authority to require an assessment using the newer models if there is reason to believe there is an environmental impact from that facility.

Q. How will the Ministry deal with improvements to the models as scientific advancements are made?

A. One of the reasons MOE is moving the technical details of modelling from the regulation into a guideline is because it is recognized that scientific advancements in modelling will be made and that these improvements should be incorporated into the guide in a reasonable time frame. However, if MOE decided to introduce new models or, for example, change the screening model from SCREEN3 to a screening version of AERMOD, then as a minimum this would be posted on Environmental Registry for stakeholder input and appropriate consultation with stakeholders will take place.

Appendix C

Proposed format for

"Introducing Effects-based Averaging Times into O. Reg. 346"

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Group of 9 Standards - from March, 1998 consultation				
Acetaldehyde	75-07-0	500 (G)	health	existing
Carbon Tetrachloride	56-23-5	7.2 (G)	health	existing
1,4 Dichlorobenzene	106-46-7	285 (G)	health	existing
1,2 Dichloroethane (Ethylene Dichloride)	107-06-2	6 (G)	health	existing
Formaldehyde	50-00-0	65	odour	existing
Methylene Chloride (Dichloromethane)	75-09-2	5300	RM	existing
		660 (G)	health	phase-in over "x" years
Perchloroethylene (Tetrachloroethylene)	127-18-4	10000	RM	existing
		1080 (G)	health	phase-in over "x" years
Styrene	100-42-5	400	health & odour	existing
Trichloroethylene	79-01-6	85000 (S)		existing
		3500 (G)	RM	interim
		350	health	phase-in over "x" years

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Group of 18 Standards - from February, 2000 consultation				
Acrylonitrile	107-13-1	300	health	existing
		180 (upper range)	RM	interim (phase-in over 6 months)
		1.8	health	phase-in over "x" years
Ammonia	7664-41-7	3600	odour	existing
		~~3000 (upper range)~~	RM	
		300	health	phase-in over "x" years
Chlorine	7782-50-5	300 (upper range)	RM (health)	existing
		30	health	phase-in over "x" years
Chloroform	67-66-3	1500 (G)	health	existing
		300 (upper range)	RM	interim (phase-in over 6 months)
		3	health	phase-in over "x" years
Ethyl Benzene	100-41-4	4000	odour	existing
		3000	health	interim (phase-in over 6 months)
		1400	odour	phase-in over "x" years

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Ethyl Ether	60-29-7	30000 (G)		existing
		7000 (upper range)	RM	interim (phase-in over 6 months)
		700	odour	phase-in over "x" years
n-Heptane	142-82-5	33000	health	phase-in over 6 months
n-Hexane	110-54-3	35000 (G)	RM (health)	existing
		~~(600-6000) (range)~~	no decision	
		7500	health	see new proposal on Environmental Registry
Hydrogen Chloride	2099048	100	corrosion	existing
		60	health	phase-in over "x" years
Isopropyl Benzene	98-82-8	100 (G)	odour	existing
Methanol	67-56-1	84000	health	existing
		12000	health	phase-in over 6 months
Methyl Ethyl Ketone	78-93-3	31000	odour	existing
		30000 (upper range)	RM	interim (phase-in over 6 months)
		3000	health	phase-in over "x" years
Methyl Isobutyl Ketone	108-10-1	1200 (G)	odour	existing

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Mineral Spirits	8052-41-3	30000 (G)	odour	existing
		~~30000 (upper range)~~		
		7800	health	interim (phase-in over 6 months)
		3000	odour	phase-in over "x" years
Propylene Oxide	75-56-9	13500 (G)	health	existing
		450 (upper range)	RM	interim (phase-in over 6 months)
		4.5	health	phase-in over "x" years
Toluene	108-88-3	2000	odour	existing
Vinylidene Chloride	75-35-4	30	health	phase-in over 6 months
Xylenes	1330-20-7	2300	odour	existing
Reaffirmation of 75 existing standards as being adequately protective - February, 2000				
Acetophenone	98-86-2	625(G)	odour	existing
Acetylene	74-86-2	56000	odour	existing
Aluminum oxide	1344-28-1	100 (G)	particulate	existing
Ammonium chloride	12125-02-9	100 (G)	particulate	existing
Barium - total water soluble	7440-39-3	30 (G)	health	existing
Benzyl alcohol	100-51-6	2640 (G)	health	existing
Beryllium and compounds	7440-41-7	0.03 (S)	health	existing
Bromacil	314-40-9	30 (G)	health	existing
Butyl acetate, –	123-86-4	735 (G)	Odour	existing
Butyl acrylate	141-32-2	100 (G)	particulate	existing

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Calcium cyanide (as total salt)	592-01-8	100 (G)	particulate	existing
Calcium hydroxide	1305-62-0	27 (S)	corrosion	existing
Calcium oxide	1305-78-8	20 (S)	corrosion	existing
Captan	133-06-2	75 (G)	health	existing
Carbon disulphide	75-15-0	330 (S)	odour	existing
Carbon monoxide	630-08-0	6000 (S)	health	existing
Citric acid	77-92-9	100 (G)	particulate	existing
Dalapon sodium salt	127-20-8	100 (G)	health	existing
Diacetone alcohol	123-42-2	990 (G)	odour	existing
Dibutyl phthalate (DBP)	84-74-2	100 (G)	health	existing
Dichloroethylene, cis-1,2-	156-59-2	315 (G)	health	existing
Dichloroethylene, sym-1,2-	540-59-0	315 (G)	health	existing
Dichloroethylene, trans-1,2-	156-60-5	315 (G)	health	existing
Diethyl phthalate (DEP)	84-66-2	100 (G)	health	existing
Diisobutyl ketone	108-83-8	470 (G)	odour	existing
Dimethyl acetamide, n,n-	127-19-5	900 (G)	health	existing
Dimethyl methylphosphonate	756-79-6	875 (24-hr AAQC)	health	existing
Dimethyl phthalate (DMP)	131-11-3	100 (G)	health	existing
Dioxolane, 1,3-	646-06-0	30 (G)	health	existing
Diphenylamine	122-39-4	50 (G)	health	existing
Diquat dibromide, respirable	85-00-7	0.096 (G)	health	existing
Diquat dibromide, total in ambient air	85-00-7	0.48 (G)	health	existing

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Ethanol (Ethyl alcohol)	64-17-5	19000 (G)	odour	existing
Ethyl acetate	141-78-6	19000 (S)	odour	existing
Ethyl acrylate	140-88-5	4.5 (S)	odour	existing
Ethyl hexanol, 2-	104-76-7	600 (G)	odour	existing
Ethyl-3-ethoxy propionate	763-69-9	147 (G)	odour	existing
Ethylene glycol dinitrate	628-96-6	10 (G)	health	existing
Ferric oxide	1309-37-1	75 (S)	soiling	existing
Hexamethyl disilazane	999-97-3	5 (G)	health	existing
Hydrogen peroxide	7722-84-1	90 (G)	health	existing
Isobutyl acetate	110-19-0	1220 (G)	odour	existing
Isopropyl acetate	108-21-4	1470 (G)	odour	existing
Magnesium oxide	1309-48-4	100 (S)	particulate	existing
Magnesium stearate	557-04-0	100 (G)	particulate	existing
Methacrylic acid	79-41-4	2000 (G)	odour	existing
Methyl acrylate	96-33-3	4 (S)	odour	existing
Methyl methacrylate	80-62-6	860 (S)	odour	existing
Molybdenum	7439-98-7	100 (G)	particulate	existing
Monomethyl amine	74-89-5	25 (S)	odour	existing
Nitric acid	7697-37-2	100 (S)	corrosion	existing
Nitroglycerine	55-63-0	10 (G)	health	existing
Oleic acid	112-80-1	6 (G)	health	existing
Oxalic acid	144-62-7	75 (G)	health	existing
Oxo-heptyl acetate	90438-79-2	255 (G)	health	existing
Oxo-hexyl acetate	88230-35-7	255 (G)	health	existing
Phosphorus oxychloride	10025-87-3	40 (G)	health	existing
Phosphorus pentachloride	10026-13-8	30 (G)	health	existing
Polychlorinated biphenyls (PCBs)	1336-36-3	0.45 (G)	health	existing
Potassium cyanide	151-50-8	100 (G)	particulate	existing

Table C-1: Screening Levels for Contaminants

Contaminant	Chemical Abstract Number	Maximum ½ hour average Air Quality Standard ($\mu g/m^3$)	Basis	Implementation Dates
Potassium hydroxide	1310-58-3	28 (G)	corrosion	existing
Propionaldehyde	123-38-6	7 (G)	odour	existing
Propionic acid	79-09-4	100 (G)	odour	existing
Propionic anhydride (as Propionic acid)	123-62-6	100 (G)	odour	existing
Propylene glycol	57-55-6	100 (G)	health	existing
Silver	7440-22-4	3 (S)	health	existing
Sodium bisulphite	7631-90-5	100 (G)	particulate	existing
Sodium chlorate	2146050	18 (G)	health	existing
Sodium cyanide	143-33-9	100 (G)	particulate	existing
Tetramethyl thiuram disulphide	137-26-8	30 (G)	health	existing
Tin	7440-31-5	30 (S)	health	existing
Titanium dioxide	13463-67-7	100 (S)	health	existing
Tributyltin oxide	56-35-9	0.42 (G)	health	existing
Trichlorobenzene, 1,2,4-	120-82-1	100 (G)	irritant	existing
Trimethyl amine	75-50-3	0.5 (G)	odour	existing

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Group of 9 standards- from Mar, 1998 consultation					
Acetaldehyde	75-07-0	500 (G)	24-hour average	health	existing
Carbon Tetrachloride	56-23-5	2.4	24-hour average	health	existing
1,4 Dichlorobenzene	106-46-7	95	24-hour average	health	existing
1,2 Dichloroethane (Ethylene Dichloride)	107-06-2	2	24-hour average	health	existing
Formaldehyde	50-00-0	65	24-hour average	health	existing
		88	10-minute average	odour	proposed
Methylene Chloride (Dichloromethane)	75-09-2	220	24-hour average	health	existing
Perchloroethylene	127-18-4	360	24-hour average	health	existing
Styrene	100-42-5	400	24-hour average	health	existing
		545	10-minute average	odour	proposed
Trichloroethylene	79-01-6	115	24-hour average	health	existing(interim)
Group of 18 Standards - from February, 2000 consultation					
Acrylonitrile	107-13-1	100	24-hour average	health	existing
		0.6	24-hour average	health	phase-in over "x" years
Ammonia	7664-41-7	~~3600~~	~~24-hour average~~	~~odour~~	~~existing~~
		4900	10-minute average	odour	proposed
		100	24-hour average	health	phase-in over "x" years

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Chlorine	7782-50-5	150	24-hour average	health	existing
		10	24-hour average	health	phase-in over "x" years
		230	10- minute average	odour	phase-in over 6 months
Chloroform	67-66-3	500	24-hour average	health	existing
		1	24-hour average	health	phase-in over "x" years
Ethyl Benzene	100-41-4	1900	10-minute average	odour	phase-in over 6 months
		1000	24-hour average	health	phase-in over "x" years
Ethyl Ether	60-29-7	30000	24-hour average	health	existing
		8000	24-hour average	health	phase-in over "x" years
		950	10-minute average	odour	phase-in over 6 months
n-Heptane	142-82-5	11000	24-hour average	health	phase-in over 6 months
n-Hexane	110-54-3	12000	24-hour average	health	existing
		2500	24-hour average	health	see new proposal on Environmental Registry
Hydrogen Chloride	2099048	40	24-hour average	corrosion	existing
		20	24-hour average	health	phase-in over "x" years

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Isopropyl Benzene	98-82-8	~~100~~	~~1 hour~~	~~odour~~	~~existing~~
		136	10-minute average	odour	proposed
		400	24-hour average	health	existing
Methanol	67-56-1	28000	24-hour average	health	existing
		4000	24-hour average	health	phase-in over 6 months
Methyl Ethyl Ketone	78-93-3	~~31000~~	~~1 hour average~~	~~odour~~	~~existing~~
		42000	10-minute average	odour	proposed
		1000	24-hour average	health	phase-in over "x" years
Methyl Isobutyl Ketone	108-10-1	~~1200~~	~~24-hour average~~	~~odour~~	~~existing~~
		1630	10-minute average	odour	proposed
Mineral Spirits	8052-41-3	10000	24-hour average	health	existing
		2600	24-hour average	health	phase-in over "x" years
Propylene Oxide	75-56-9	4500	24-hour average	health	existing
		1.5	24-hour average	health	phase-in over "x" years
Toluene	108-88-3	~~2000~~	~~24-hour average~~	~~odour~~	~~existing~~
		2700	10-minute average	odour	proposed
		3750	24-hour average	health	proposed
Vinylidene Chloride	75-35-4	35	24-hour average	health	existing
		10	24-hour average	health	phase-in over 6 months

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Xylenes	1330-20-7	~~2300~~	~~24-hour average~~	~~odour~~	~~existing~~
		3130	10-minute average	odour	existing
		under review	24-hour average	health	phase-in over "x" years
Reaffirmation of 75 existing standards as being adequately protective - Feb/00					
Acetophenone	98-86-2	1167	1-hour average	health	existing
		850	10-minute average	odour	existing
Acetylene	74-86-2	76000	10-minute average	odour	proposed
Aluminum oxide	1344-28-1	120	24-hour average	particulate	existing
Ammonium chloride	12125-02-9	120	24-hour average	particulate	existing
Barium - total water soluble	7440-39-3	10	24-hour average	health	existing
Benzyl alcohol	100-51-6	880	24-hour average	health	existing
Beryllium and compounds	7440-41-7	0.01	24-hour average	health	existing
Bromacil	314-40-9	10	24-hour average	health	existing
Butyl acetate, n –	123-86-4	1000	10-minute average	odour	existing
		15000	1-hour average	health	existing
		~~248~~	~~24-hour average~~	~~odour~~	~~existing~~
Butyl acrylate	141-32-2	120	24-hour average	particulate	existing
Calcium cyanide (as total salt)	592-01-8	120	24-hour average	particulate	existing
Calcium hydroxide	1305-62-0	13.5	24-hour average	corrosion	existing
Calcium oxide	1305-78-8	10	24-hour average	corrosion	existing
Captan	133-06-2	25	24-hour average	health	existing
Carbon disulphide	75-15-0	~~330~~	~~24-hour average~~	~~odour~~	~~existing~~
		450	10-minute average	odour	proposed
Carbon monoxide	630-08-0	36200	1-hour average	health	existing
		15700	8-hour average	health	existing
		15700	24 hour average	health	existing
Citric acid	77-92-9	300	1-hour average	health	existing
		120	24-hour average	particulate	existing
Dalapon sodium salt	127-20-8	50	24-hour average	health	existing

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Diacetone alcohol	123-42-2	~~335~~	~~24-hour average~~	~~odour~~	~~existing~~
		1350	10 minute average	odour	existing
Dibutyl phthalate (DBP)	84-74-2	50	24-hour average	health	existing
Dichloroethylene, cis-1,2-	156-59-2	105	24-hour average	health	existing
Dichloroethylene, sym-1,2-	540-59-0	105	24-hour average	health	existing
Dichloroethylene, trans-1,2-	156-60-5	105	24-hour average	health	existing
Diethyl phthalate (DEP)	84-66-2	125	24-hour average	health	existing
Diisobutyl ketone	108-83-8	649	10- minute average	odour	existing
		3500	24-hour average	health	existing
Dimethyl acetamide, n,n-	127-19-5	300	24-hour average	health	existing
Dimethyl methylphosphonate	756-79-6	875	24-hour average	health	existing
Dimethyl phthalate (DMP)	131-11-3	125	24-hour average	health	existing
Dioxolane, 1,3-	646-06-0	10	24-hour average	health	existing
Diphenylamine	122-39-4	17.5	24-hour average	health	existing
Diquat dibromide, respirable	85-00-7	0.032	24-hour average	health	existing
Diquat dibromide, total in ambient air	85-00-7	0.16	24-hour average	health	existing
Ethanol (Ethyl alcohol)	64-17-5	~~19000~~	~~1-hour average~~	~~odour~~	~~existing~~
		25800	10-minute average	odour	proposed
Ethyl acetate	141-78-6	~~19000~~	~~1-hour average~~	~~odour~~	~~existing~~
		25800	10-minute average	odour	proposed
Ethyl acrylate	140-88-5	~~4.5~~	~~1-hour average~~	~~odour~~	~~existing~~
		6.1	10-minute average	odour	proposed
Ethyl hexanol, 2-	104-76-7	~~600~~	~~1-hour average~~	~~odour~~	~~existing~~
		815	10-minute average	odour	proposed

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Ethyl-3-ethoxy propionate	763-69-9	~~50~~	~~24-hour average~~	~~odour~~	~~existing~~
		200	10-minute average	odour	proposed
Ethylene glycol dinitrate	628-96-6	3	24-hour average	health	existing
Ferric oxide	1309-37-1	25	24-hour average	soiling	existing
Hexamethyl disilazane	999-97-3	2	24-hour average	health	existing
Hydrogen peroxide	7722-84-1	30	24-hour average	health	existing
Isobutyl acetate	110-19-0	~~412~~	~~24-hour average~~	~~odour~~	~~existing~~
		1660	10-minute average	odour	proposed
Isopropyl acetate	108-21-4	~~500~~	~~24-hour average~~	~~odour~~	~~existing~~
		2000	10-minute average	odour	proposed
Magnesium oxide	1309-48-4	120	24-hour average	particulate	existing
Magnesium stearate	557-04-0	35	24-hour average	health	existing
Methacrylic acid	79-41-4	~~2000~~	~~24-hour average~~	~~odour~~	~~existing~~
		2700	10-minute average	odour	proposed
Methyl acrylate	96-33-3	~~4~~	~~(1-hr)~~	~~odour~~	~~existing~~
		5.4	10-minute average	odour	proposed
Methyl methacrylate	80-62-6	~~860~~	~~24-hour average~~	~~odour~~	~~existing~~
		1170	10-minute average	odour	proposed
Molybdenum	7439-98-7	120	24-hour average	particulate	existing
Monomethyl amine	74-89-5	~~25~~	~~24-hour average~~	~~odour~~	~~existing~~
		34	10-minute average	odour	proposed
Nitric acid	7697-37-2	35	24-hour average	corrosion	existing
Nitroglycerine	55-63-0	3	24-hour average	health	existing
Oleic acid	112-80-1	5	1-hour average	health	existing
Oxalic acid	144-62-7	25	24-hour average	health	existing
Oxo-heptyl acetate	90438-79-2	85	24-hour average	health	existing
Oxo-hexyl acetate	88230-35-7	85	24-hour average	health	existing
Phosphorus oxychloride	10025-87-3	12	24-hour average	health	existing
Phosphorus pentachloride	10026-13-8	10	24-hour average	health	existing
Polychlorinated biphenyls (PCBs)	1336-36-3	0.15	24-hour average	health	existing

Table C-2: Effects-based Averaging Times

Contaminant	Chemical Abstract Number	Air Quality Standard ($\mu g/m^3$)	Averaging Period	Basis for Air Quality Standard	Implementation Dates
Potassium cyanide	151-50-8	120	24-hour average	particulate	existing
Potassium hydroxide	1310-58-3	14	24-hour average	corrosion	existing
Propionaldehyde	123-38-6	~~2.5~~	~~24-hour average~~	~~odour~~	~~existing~~
		10	10 minute average	odour	proposed
Propionic acid	79-09-4	~~100~~	~~1-hour average~~	~~odour~~	~~existing~~
		135	10-minute average	odour	proposed
Propionic anhydride (as Propionic acid)	123-62-6	~~100~~	~~1-hour average~~	~~odour~~	~~existing~~
		135	10-minute average	odour	proposed
Propylene glycol	57-55-6	120	24-hour average	health	existing
Silver	7440-22-4	1	24-hour average	health	existing
Sodium bisulphite	7631-90-5	120	24-hour average	particulate	existing
Sodium chlorate	2146050	6	24-hour average	health	existing
Sodium cyanide	143-33-9	120	24-hour average	particulate	existing
Tetramethyl thiuram disulphide	137-26-8	10	24-hour average	health	existing
Tin	7440-31-5	10	24-hour average	health	existing
Titanium dioxide	13463-67-7	34	24-hour average	health	existing
Tributyltin oxide	56-35-9	0.14	24-hour average	health	existing
Trichlorobenzene, 1,2,4-	120-82-1	400	24-hour average	irritant; health	existing
Trimethyl amine	75-50-3	~~0.5~~	~~1-hour average~~	~~odour~~	~~existing~~
		0.68	10-minute average	odour	proposed